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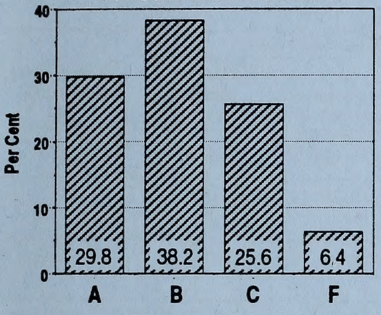
CANADIANA

SEP 28 1992

Physics 30

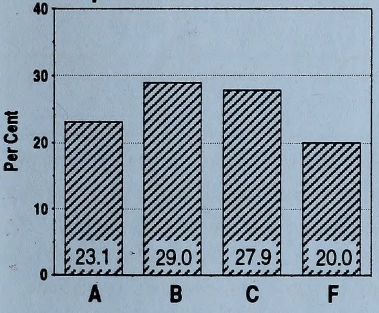
Diploma Examination Results
Examiners' Report for June 1992


School-Awarded Mark

The summary information in this report provides teachers, school administrators, students, and the general public with an overview of results from the June 1992 administration of the Physics 30 Diploma Examination. This information is most helpful when used in conjunction with the detailed school and jurisdiction reports that have been mailed to schools and school jurisdiction offices. An annual provincial report containing a detailed analysis of the combined January, June, and August results will be available this fall.

Description of the Examination

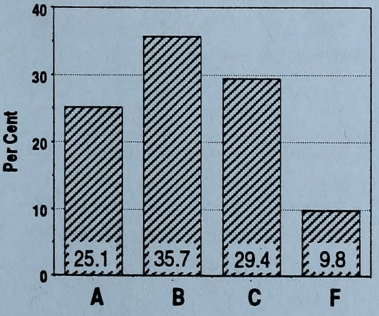
The Physics 30 Diploma Examination consists of three parts: a multiple-choice section of 42 questions worth 60%, a numerical-response section of seven questions worth 10%, and a written-response section of four questions worth 30% of the total examination mark.


Diploma Examination Mark

Achievement of Standards

The information reported is based on the final blended marks achieved by 4 953 students who wrote the June 1992 examination.

- 90.2% of these students achieved the acceptable standard (a final blended mark of 50% or higher).
- 25.1% of these students achieved the standard of excellence (a final blended mark of 80% or higher).


Final Blended Mark

Overall, student performance in Physics 30 was satisfactory. Students' problem-solving skills continued to improve and they showed a good understanding of course content.

Provincial Averages

- The average school-awarded mark was 70.7%.
- The average diploma examination mark was 64.8%.
- The average final blended mark, representing an equal weighting of the school-awarded mark and the diploma examination mark, was 68.1%.

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Results and Examiners' Comments

Subtest

When analyzing detailed examination results, please bear in mind that subtest results **cannot** be directly compared.

Results are in average raw scores.

Machine scored: 34.5 out of 49

Written response: 10.8 out of 21

Course Content

- Light: 11.1 out of 16
- Electric and Magnetic Fields: 12.5 out of 19
- Electromagnetic Radiation: 6.6 out of 10
- Structure of Matter: 9.1 out of 14
- Modern Physical Theories: 6.0 out of 11

Process Skills: 21.4 out of 37

- Multiple-choice questions 2, 4, 5, 9, 12, 15, 26, 27, 29, 30, 32, 35, 38, and 40; numerical-response questions 1 and 3; and written-response questions 1, 2, 3, and 4

Cognitive Levels

- Knowledge: 11.6 out of 17
- Comprehension and Application: 24.6 out of 35
- Higher Mental Activities: 9.0 out of 18

Examination Blueprint

Each question on the examination is classified in two ways: according to the curricular content area being tested and according to the cognitive level demanded by the question. The examination blueprint illustrates the distribution of questions in June 1992 according to these classifications. Numbers with brackets [ ] indicate written-response questions, those with parentheses ( ) indicate numerical-response questions, and those without brackets or parentheses are multiple-choice questions.

Reporting Category	Questions by Cognitive Level			Examination Emphasis (%)
	Knowledge	Comprehension and Application	Higher Mental Activities	
Light	3, 6, 7, 10	1, 8, 9, 11; (1); [2]	2, 4, 5	23
Electric and Magnetic Fields	13, 18, 19, 21	12, 14, 15, 16, 17, 20, 22; (2), (3)	[3]	27
Electromagnetic Radiation	23, 24, 25	27, 28, 29; (4), (5)	26, 30	14
Structure of Matter	31, 33, 34, 36	37; (6); [1]	32, 35	20
Modern Physical Theories	39, 41	38, 40, 42; (7)	[4]	16
Examination Emphasis (%)	24	50	26	100

This examination has a balance of question types and difficulties. It is designed so that students capable of achieving the acceptable standard will obtain a mark of 50% or higher and students capable of achieving the standard of excellence will obtain a mark of 80% or higher. This examination again included numerical-response questions, which students handled very well. Students achieving the acceptable standard were expected to show good communication skills in the written-response section of the examination, regardless of whether their answers were in calculation or verbal form.

Approximately 10% of the students who wrote this examination had written at least one other Physics 30 Diploma Examination. Most of these students either failed or scored below the provincial mean on their first writing. Although this group averaged almost 5% less than those students who wrote the examination for the first time, their average increased by almost 9% over their previous examination score.

Multiple Choice

Question	Key	Difficulty*	Question	Key	Difficulty*	Question	Key	Difficulty*
1	B	91.0	15	A	71.8	29	A	70.9
2	B	79.5	16	A	90.5	30	D	35.6
3	C	59.2	17	C	83.7	31	D	87.5
4	D	55.9	18	C	49.4	32	A	60.7
5	A	71.0	19	A	63.2	33	B	70.6
6	B	73.1	20	A	57.0	34	D	64.8
7	A	86.6	21	B	85.8	35	C	52.3
8	C	91.0	22	C	76.9	36	B	57.5
9	D	73.5	23	D	65.5	37	A	43.8
10	C	63.4	24	B	80.4	38	C	78.4
11	D	74.3	25	D	40.8	39	D	71.4
12	C	81.1	26	D	59.3	40	B	46.4
13	B	60.4	27	A	68.6	41	A	82.1
14	D	94.0	28	C	95.4	42	C	80.8

*Difficulty—percentage of students answering the question correctly

Multiple Choice and Numerical Response

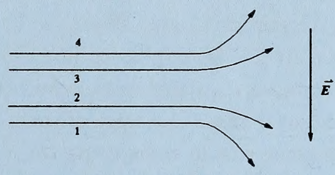
All students were expected to demonstrate a high level of competence in calculations. Students achieving the standard of excellence were expected to apply their knowledge to unusual problems and to use scientific generalizations effectively. Students' performance on the machine-scored sections of the examination was generally satisfactory. The average score for the machine-scored sections was 70.4%. Students found the calculation questions to be the easiest. For a complete breakdown of student responses by alternative for the multiple-choice questions, please refer to the school and jurisdiction reports. Detailed comments on selected questions from the multiple-choice and numerical-response sections follow.

Multiple Choice

In **question 12,** students were asked to examine the paths of four charged particles having equal masses and travelling at the same speed in an electric field. From the paths these particles travelled, students were to determine which of four statements correctly described the nature of the charges on two of the particles. The key concepts students were expected to understand were that the sign of the charge determines the direction of the electrical force and that the magnitude of the charge determines the magnitude of the force and therefore the amount of curvature in the path. Well over three-quarters of the students achieving at the acceptable standard answered this question correctly.

Use the following information to answer question 12.

Paths of Charged Particles in an Electric Field



The masses and speeds of the particles are equal.

12. Which statement is true?

- **A.** The charges on particles 2 and 3 are equal in magnitude and in sign.
- **B.** The charges on particles 3 and 4 are equal in magnitude and in sign.
- • **C.** The charges on particles 2 and 3 are equal in magnitude but not in sign.
- **D.** The charges on particles 3 and 4 are equal in magnitude but not in sign.

Question 35 required students to demonstrate their understanding of the photoelectric effect in terms of the conservation of energy law. They were expected to find the total energy of the incident photon in terms of h and f_o and to subtract the amount of energy required to overcome the work function of the metal. Students achieving the standard of excellence had little difficulty with this question. Of the students who answered this question incorrectly, those achieving at the acceptable standard but not at the standard of excellence tended not to use the law of conservation of energy. They also ignored the work function of the metal.

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35. A metal surface has a threshold frequency of f_o. If the metal surface is illuminated with radiation of a frequency of $3.5f_o$, then the maximum kinetic energy of emitted photoelectrons is

- **A.** $4.5hf_o$
- **B.** $3.5hf_o$
- • **C.** $2.5hf_o$
- **D.** $1.0hf_o$

Numerical Response

Question	Answer	Difficulty*
1	36.0	89.5
2	4.98	60.5
3	13.0	69.7
4	2.11	87.3
5	2.56	58.1
6	19.0	80.5
7	8.38	63.0

*Difficulty—percentage of students answering the question correctly

Most students correctly followed the instructions for filling in the answer sheet. All seven questions discriminated well between those students who reached an acceptable standard and those who did not. The questions showed that students achieving the acceptable standard can generate a correct response for questions that have an open-ended format.

3. A household circuit that can maintain a maximum current of 15.0 A with a potential difference of 120 V runs **three** 75.0 W light bulbs and a 7.50×10^2 W toaster. The **maximum** number of 60.0 W light bulbs that can be added to this circuit without overloading it is _______bulbs.

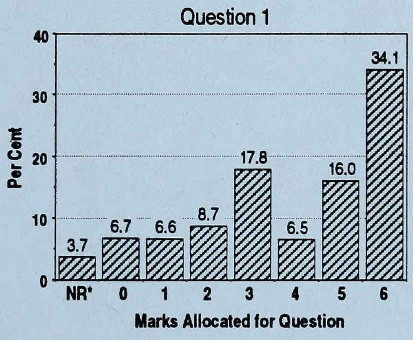
Question 3 was answered correctly by 69.7% of the students. They were required first to determine the maximum energy output for an electrical circuit and then to determine the number of specific appliances that could be operated without overloading the circuit. Students achieving the acceptable standard were expected to answer this question correctly and over three-quarters of them were successful. The most common error was in calculating the rate of energy consumption for the appliances already on the circuit. Many students used only one 75-watt bulb in their calculation rather than three. Another common error was failing to realize that the number of light bulbs had to be rounded down rather than up since it is not possible to have a fractional number of light bulbs. Students gave answers of 14 or 13.8 bulbs instead of the correct answer of 13 bulbs. Those students who committed this latter error were those not achieving the standard of excellence.

5. The distance from the Earth to the moon is 3.84×10^5 km. Using infra-red radiation, the time required for a signal to go to the moon and to return is _______s.

Question 5 was the most difficult question in the numerical-response section, with 58.1% of the students answering it correctly. Students were expected to double the distance from the Earth to the moon and convert the distance to metres. This distance was to be divided by the speed of light to yield the correct answer. Approximately 18%, including a significant number of those students achieving the standard of excellence, did not double the distance for the time calculation. Conversely, students who did not achieve the standard of excellence more commonly neglected to convert kilometres to metres; approximately 6% of the students made this second mistake. A smaller number of students made both errors.

Written Response

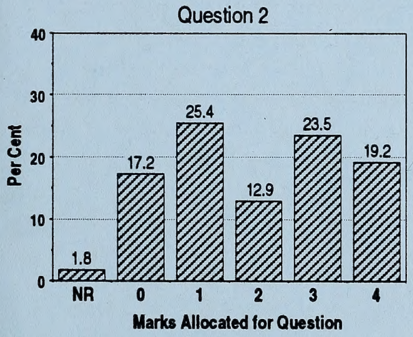
The four questions in the written-response section were created from four of the five strands for Physics 30. Students' problem-solving skills were tested most in questions 1c and 2, in parts b and c of question 3, and in question 4. Students achieving the acceptable standard on this examination were expected to get 3 out of 6 marks on each of questions 1 and 3, 2 out of 4 marks on question 2, and only 2 out of 5 marks on question 4. Students performing at a standard of excellence were expected to obtain near full marks on questions 1 and 2, 5 out of 6 marks on question 3, and 3 out of 5 marks on question 4.



*NR—No Response

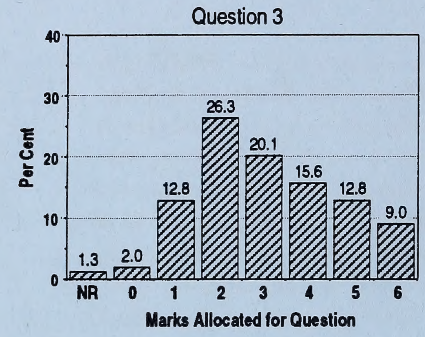
Question 1 was answered well. Parts a and b involved routine calculations in which students could directly apply equations from the data booklet with some transposition. Students achieving the acceptable standard had little trouble with these two parts. Part c required students to apply the law of conservation of energy by equating the change in electric potential energy to the kinetic energy the ion gained. Students achieving the standard of excellence had little difficulty with this part. Students achieving the acceptable standard but not the standard of excellence tended to apply equations from the data booklet without indicating that they were using a conservation law. Some of these students confused electric potential energy with electric field.

On this 6-mark question, the average mark was 3.88 or 65%.



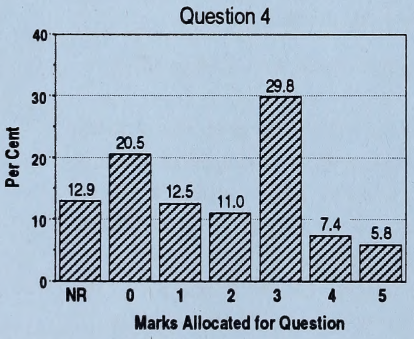
In **question 2,** students were presented with a problem that had a familiar context. Students achieving at the acceptable standard were expected to solve for the angle of refraction and attempt to use trigonometry to find the actual depth. Many of these students were unable to use the correct trigonometric ratios and often applied the ratios to an oblique triangle. Students achieving the standard of excellence generally solved the problem correctly. These students had little difficulty using trigonometry and some even used the law of sines or the law of cosines to find the actual depth of the pool. Students achieving the acceptable standard but not the standard of excellence tended to make errors in significant digits.

On this 4-mark question, the average mark was 1.99 or 50%.



Question 3 proved to be challenging. Most students graphed the experimental data correctly in part a, but students not achieving the standard of excellence experienced difficulty with either part b or part c, or both. Many of these students did not draw a relationship between the graph and the formula given and, therefore, did not use the vertical intercept and the slope to solve parts b and c respectively. Rather, they usually solved part c by relating the function directly to the data. These students experienced difficulty in finding the average and rarely considered a slope calculation to be a suitable averaging technique. In fact, some students found the slope and used it as the ohmic resistance in their solution for part b, and then used another averaging method to find the required ohmic resistance in part c. Many used the averages for potential difference and current as co-ordinates for a point described by the given relation and solved for the ohmic resistance using the data booklet values for the constants. On the other hand, students achieving the standard of excellence consistently related the vertical intercept of the graph to the function needed to solve part b, and for part c used either a correct averaging procedure or a slope calculation. The slope method was used less often.

On this 6-mark question, the average mark was 3.06 or 51%.



In **question 4,** students were asked to explain, with the use of supporting calculations, why the de Broglie wavelength cannot be observed for large objects but can be for subatomic particles. Students achieving at the acceptable standard but not at the standard of excellence calculated the de Broglie wavelengths for the automobile and the electron. They generally stated that the de Broglie wave for the automobile could not be observed because of its small magnitude compared to the size of the automobile rather than related the de Broglie wavelength to a diffraction or interference phenomenon. These students also had difficulty outlining relevant experiments or experimental evidence. Students achieving the standard of excellence often referred to diffraction experiments that were similar to Young's experiment and were thus not suitable for wavelengths having a magnitude of 10^{-10} m. They did not realize that in order to observe interference, the diffracting medium needs to be comparable in size to the wavelength being diffracted, and that in the absence of such a medium, the wave nature of the automobile cannot be observed.

On this 5-mark question, the average mark was 1.83 or 37%.

For further information, contact Jack Edwards, Lowell Hackman, or Phill Campbell at the Student Evaluation Branch, 427-2948.